

Claims

We claim:

- 5 1. A method for transferring messages among an application program and a plurality of protocol layers in a communication subsystem of a computer using a communication subsystem controller, the computer being connected to a communication network and having a memory and at least one processor, the method comprising the steps of:
- 10 building a protocol stack using the plurality of protocol layers and the communication subsystem controller, wherein the communication subsystem controller forms interfaces between the application program and its adjacent protocol layer in the protocol stack and at least between a pair of adjacent protocol layers in the protocol stack for transferring messages;
- 15 enabling the adjacent protocol layer to the application program to be an application service provider in response to the application program; enabling a first protocol layer in the pair of adjacent protocol layers in the protocol stack to be a protocol service provider in response to a second protocol layer in the pair of adjacent protocol layers in the protocol stack;
- 20 transferring messages between the application program and the application service provider, further including the steps of: transferring messages between the application program and the communication subsystem controller, and

transferring messages between the communication subsystem controller and the application service provider; and
transferring messages between the second protocol layer and the protocol service provider, further including the steps of:

- 5 transferring messages between the second protocol layer and the communication subsystem controller, and
 transferring messages between the communication subsystem controller and the protocol service provider.

10 13. The method as in Claim 1, wherein the step of building the protocol stack using the plurality of protocol layers and the communication subsystem controller further includes the step of building the protocol stack according to a set of predetermined protocol stack information stored in the memory, wherein the set of predetermined protocol stack information includes at least 15 information of the adjacent protocol layer to the application program and the pair of adjacent protocol layers in the protocol stack.

14. 3. The method as in Claim 1, wherein the step of building the protocol stack using the plurality of protocol layers and the communication subsystem controller further includes the step of storing a set of service access point information in the memory, wherein the set of service access point information includes at least information of service access points used by the adjacent 20

protocol layer to the application program and the pair of adjacent protocol layers in the protocol stack for transferring messages.

14. The method as in Claim 3, wherein the step of storing the set of service access point information in the memory further includes storing the set of service access point information in a persistent storage for restoring the protocol stack during recovery activities.
15. The method as in Claim 3, wherein the step of transferring messages between the application program and the application service provider further includes the step of transferring messages between the application program and the application service provider using a service access point according to the set of service access point information stored in the memory.
16. The method as in Claim 3, wherein the step of transferring messages between the second protocol layer and the protocol service provider further includes the step of transferring messages between the second protocol layer and the protocol service provider using a service access point according to the set of service access point information stored in the memory.
17. The method as in Claim 1, wherein the step of building the protocol stack using the plurality of protocol layers and the communication subsystem controller further includes the step of building the protocol stack using a

preselected stack of network-dependent protocol layers, wherein the preselected stack of network-dependent protocol layers provide network-dependent services to the protocol stack for connecting the computer to the communication network.

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8. The method as in Claim 7, wherein the step of building the protocol stack using the preselected stack of network-dependent protocol layers further includes the step of providing an adapter layer between the preselected stack of network-dependent protocol layers and its adjacent 10 protocol layer in the protocol stack for transferring messages between the preselected stack of network-dependent protocol layers and its adjacent protocol layer in the protocol stack.

9. The method as in Claim 8, wherein the step of building the protocol stack using the preselected stack of network-dependent protocol layer further 15 includes the step of building the protocol stack with the communication subsystem controller forming an interface between the adjacent protocol layer to the preselected stack of network-dependent protocol layers and the adapter layer for transferring messages.

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10. The method as in Claim 9, further comprising the step of transferring messages between the preselected stack of network-dependent layers and its adjacent protocol layer, further including the steps of:

transferring messages between the adjacent protocol layer to the preselected stack of network-dependent protocol layers and the communication subsystem controller,

transferring messages between the communication subsystem
5 controller and the adapter layer, and

transferring messages between the adapter layer and the preselected stack of network-dependent protocol layers.

11. The method as in Claim 1, further comprising the step of using multi-
10 threading for enabling the computer to process messages in the protocol
layers in the protocol stack.

6. The method as in Claim 1, wherein the step of transferring messages
12. between the second protocol layer and the protocol service provider further
includes the step of providing recovery information to the communication
15. subsystem controller during the transfer of messages from one of the second
protocol layer and the protocol service provider to the communication
subsystem controller.

20 13. The method as in Claim 12, wherein the step of transferring messages
between the application program and the application service provider further
includes the step of providing recovery information to the communication

subsystem controller during the transfer of messages from the application service provider to the communication subsystem controller.

8 14. The method as in Claim 13, further comprising the step of storing the
1 recovery information in a persistent storage for resuming the transfer of
5 messages during recovery activities.

15. A communication subsystem of a computer for providing connectivity to a communication network, the computer having an application program, a memory and at least one processor, wherein messages are transferred among the application program and a plurality of protocol layers in the communication subsystem using a communication subsystem controller, the communication subsystem comprising:

a protocol stack having:

15 the plurality of protocol layers, and
the communication subsystem controller, wherein the
communication subsystem controller forms interfaces between the
application program and its adjacent protocol layer in the protocol stack
and at least between a pair of adjacent protocol layers of the protocol
stack and between for transferring messages;
20 the adjacent protocol layer to the application program being enabled as
an application service provider in response to the application program; and

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a first protocol layer in the pair of adjacent protocol layers in the protocol stack being enabled as a protocol service provider in response to a second protocol layer in the pair of adjacent protocol layers in the protocol stack.

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16. The subsystem as in Claim 15, the memory further having a set of predetermined protocol stack information, wherein the set of predetermined protocol stack information includes at least information of the adjacent protocol layer to the application program and the pair of adjacent protocol
10 layers in the protocol stack.

17. The subsystem as in Claim 16, the memory further having a set of service access point information, wherein the set of service access point information includes at least information of service access points used by the
15 adjacent protocol layer to the application program and the pair of adjacent protocol layers in the protocol stack for transferring messages.

18. The subsystem as in Claim 15, further comprising a preselected stack of network-dependent protocol layers for providing network-dependent
20 services to the protocol stack for connecting the computer to the communication network.

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19. The subsystem as in Claim 18, further comprising an adapter layer between the preselected stack of network-dependent protocol layers and its adjacent protocol layer in the protocol stack, wherein the preselected stack of network-dependent protocol layers provide the network-dependent services to 5 the protocol stack through the adapter layer for connecting the computer to the communication network.

20. The subsystem as in Claim 15, the computer further having a persistent storage for storing the set of service access point information and a 10 set of recovery information to support recovery activities.

21. A program storage device readable by a computer, tangibly embodying a program of instructions executable by the computer to perform method steps for transferring messages among an application program and a plurality 15 of protocol layers in a communication subsystem of a computer using a communication subsystem controller, the computer being connected to a communication network and having a memory and at least one processor, the method steps comprising:

building a protocol stack using the plurality of protocol layers and the 20 communication subsystem controller, wherein the communication subsystem controller forms interfaces between the application program and its adjacent protocol layer in the protocol stack and at least between a pair of adjacent protocol layers in the protocol stack for transferring messages;

enabling the adjacent protocol layer to the application program to be an application service provider in response to the application program;

enabling a first protocol layer in the pair of adjacent protocol layers in the protocol stack to be a protocol service provider in response to a second
5 protocol layer in the pair of adjacent protocol layers in the protocol stack;

transferring messages between the application program and the application service provider, further including the steps of:

transferring messages between the application program and the communication subsystem controller, and

10 transferring messages between the communication subsystem controller and the application service provider; and

transferring messages between the second protocol layer and the protocol service provider, further including the steps of:

transferring messages between the second protocol layer and

15 the communication subsystem controller, and

transferring messages between the communication subsystem controller and the protocol service provider.

22. The program storage device as in Claim 21, wherein the step of
20 building the protocol stack using the plurality of protocol layers and the communication subsystem controller further includes the step of building the protocol stack according to a set of predetermined protocol stack information stored in the memory, wherein the set of predetermined protocol stack

information includes at least information of the adjacent protocol layer to the application program and the pair of adjacent protocol layers in the protocol stack.

5 23. The program storage device as in Claim 21, wherein the step of building the protocol stack using the plurality of protocol layers and the communication subsystem controller further includes the step of storing a set of service access point information in the memory, wherein the set of service access point information includes at least information of service access points
10 used by the adjacent protocol layer to the application program and the pair of adjacent protocol layers in the protocol stack for transferring messages.

24. The program storage device as in Claim 23, wherein the step of storing the set of service access point information in the memory further includes
15 storing the set of service access point information in a persistent storage for restoring the protocol stack during recovery activities.

25. The program storage device as in Claim 23, wherein the step of transferring messages between the application program and the application service provider further includes the step of transferring messages between the application program and the application service provider using a service access point according to the set of service access point information stored in
20 the memory.

26. The program storage device as in Claim 23, wherein the step of transferring messages between the second protocol layer and the protocol service provider further includes the step of transferring messages between 5 the second protocol layer and the protocol service provider using a service access point according to the set of service access point information stored in the memory.
27. The program storage device as in Claim 21, wherein the step of 10 building the protocol stack using the plurality of protocol layers and the communication subsystem controller further includes the step of building the protocol stack using a preselected stack of network-dependent protocol layers, wherein the preselected stack of network-dependent protocol layers provide network-dependent services to the protocol stack for connecting the 15 computer to the communication network.
28. The program storage device as in Claim 27, wherein the step of building the protocol stack using the preselected stack of network-dependent protocol layers further includes the step of providing an adapter layer between 20 the preselected series of network-dependent protocol layers and its adjacent protocol layer in the protocol stack for transferring messages between the preselected stack of network-dependent protocol layers and its adjacent protocol layer in the protocol stack.

29. The program storage device as in Claim 28, wherein the step of building the protocol stack using the preselected stack of network-dependent protocol layer further includes the step of building the protocol stack with the 5 communication subsystem controller forming an interface between the adjacent protocol layer to the preselected stack of network-dependent protocol layers and the adapter layer for transferring messages.

30. The program storage device as in Claim 29, the method steps further 10 comprising the step of transferring messages between the preselected stack of network-dependent layers and its adjacent protocol layer, further including the steps of:

transferring messages between the adjacent protocol layer to the preselected stack of network-dependent protocol layers and the 15 communication subsystem controller,

transferring messages between the communication subsystem controller and the adapter layer, and

transferring messages between the adapter layer and the preselected stack of network-dependent protocol layers.

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31. The program storage device as in Claim 21, the method steps further comprising the step of using multi-threading for enabling the computer to process messages in the protocol layers in the protocol stack.

32. The program storage device as in Claim 21, wherein the step of transferring messages between the second protocol layer and the protocol service provider further includes the step of providing recovery information to 5 the communication subsystem controller during the transfer of messages from one of the second protocol layer and the protocol service provider to the communication subsystem controller.
33. The program storage device as in Claim 32, wherein the step of 10 transferring messages between the application program and the application service provider further includes the step of providing recovery information to the communication subsystem controller during the transfer of messages from the application service provider to the communication subsystem controller.
- 15 34. The program storage device as in Claim 33, the method steps further comprising the step of storing the recovery information in the persistent storage for resuming the transfer of messages during recovery activities.